tech engineering news

november 1951

Another page for **YOUR BEARING NOTEBOOK**

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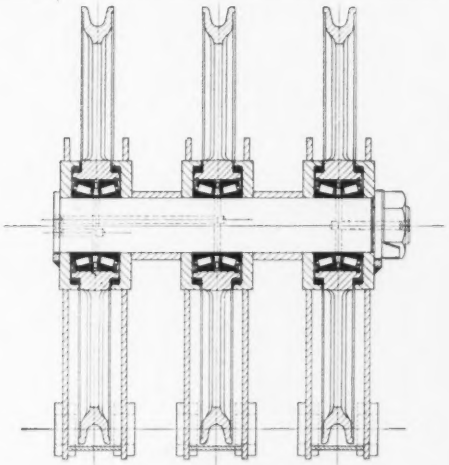
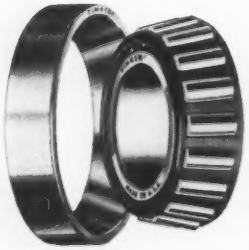
Mounting sheave bearings

The Timken bearings in this application are mounted with slotted cone spacers to provide lubrication through the shaft. The entire sheave assembly is clamped together by means of a nut and spacers between each bearing assembly. Felt seals are used. Cups are mounted with a press fit in the sheave hubs and positioned with snap rings.





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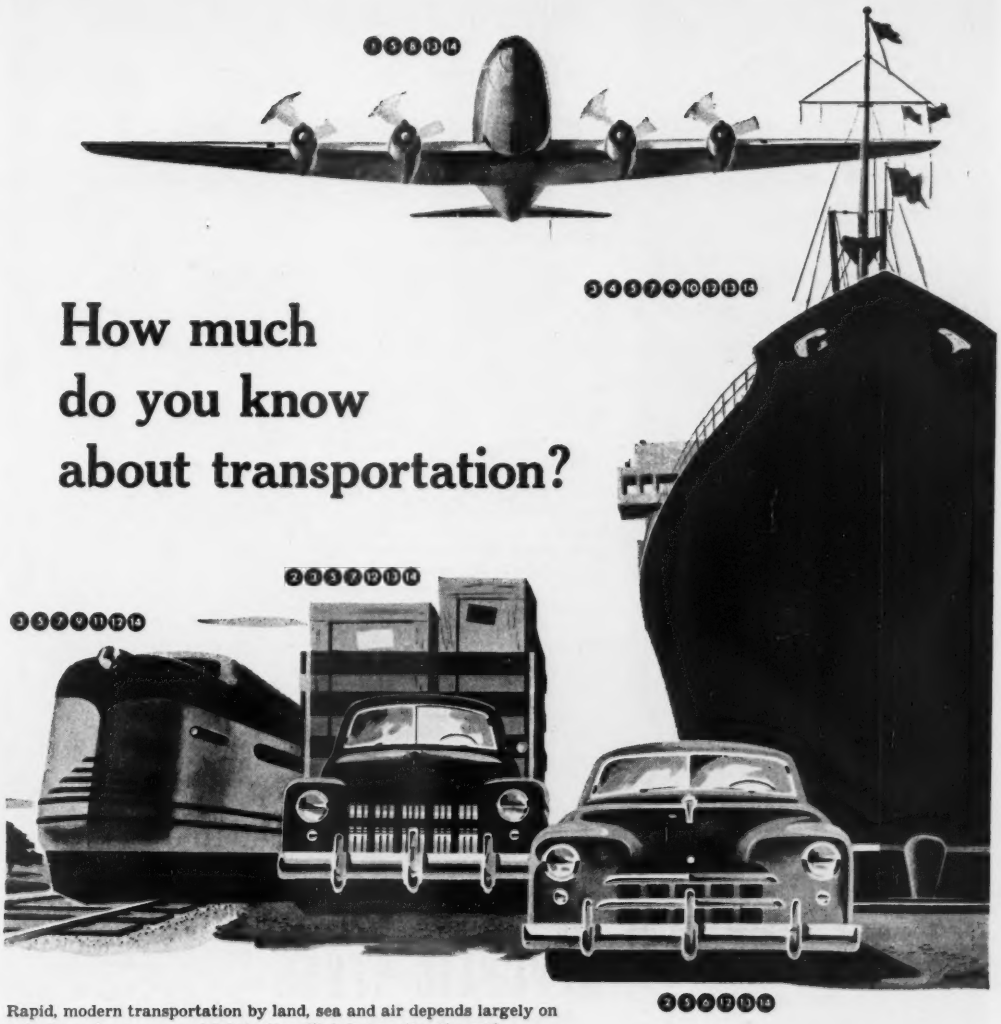
Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ◫ AND THRUST ⊣◫⊢ LOADS OR ANY COMBINATION ✳

How much do you know about transportation?



Rapid, modern transportation by land, sea and air depends largely on petroleum for power and lubrication. But few realize the wide *variety* of petroleum products required to keep travel and trade in motion. Test your own knowledge.

A few of the many petroleum products needed are listed at right. See how many you can correctly identify with the mode of transportation in which they are used. Check your estimates with the figures in the illustration.

Hand in hand with the advance of modern transportation have been many improvements in the quality of petroleum products. Behind these improvements is a vast amount of progressive, scientific research and the work of thousands of skilled people.

Good jobs with fair pay and a chance to get ahead have helped Esso Standard Oil Company to build a team of 27,000 employees. With its many years of petroleum experience, this team is constantly striving to improve the quality and value of the products at the famous Esso Sign.

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13. Hydraulic Oils
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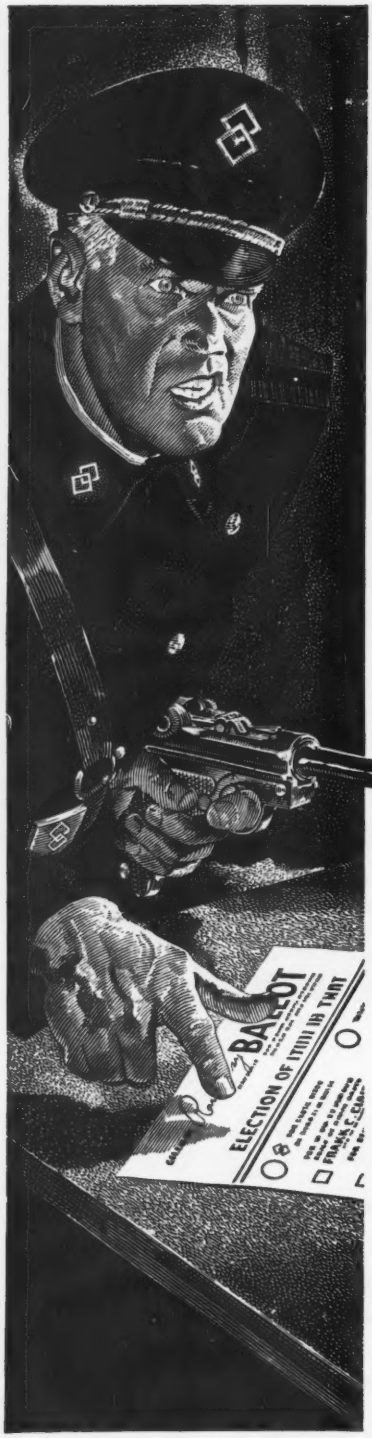
ESSO STANDARD OIL COMPANY

NOVEMBER, 1951



"Put your *X there!*"

"Ever have nightmares?

"I don't, often. But I sure had one last night! Wasn't my usual one, being chased by a lion and falling off a cliff. In *this* dream it was Election Day. I was at the polls, kidding with some of the boys I knew . . . but they weren't kidding back. They looked sort of worried or scared or something.

"Anyway, I got my ballot, stepped into the voting booth and pulled the curtain. I wet the end of the pencil . . . to make my X's big and black. *Then the nightmare part began.*

"A tough-looking soldier stepped into the booth. He put his finger on the ballot and said, *'Put your X THERE! And THERE . . . and THERE . . .'* None of the names I'd picked, either. He had a big black gun pointing right at me.

"That was last night. Today, all day, I've been thinking about it. I'd known that was how some elections got settled in other places. But it never occurred to me before how lucky I was to be a citizen of *this* country. *Here* I vote according to my conscience, not a gun. And I do other things the way I please . . . like going to church, or picking out my own kind of job down at the Republic plant. Try that where there's no freedom!

"That's it . . . *Freedom!* We've got all the Freedom in the world. But, honestly now, do we *really* appreciate it? Do *you?* I admit I've done *my* share of griping . . . probably never will get over that habit.

"But, with Freedom-grabbers at work here as well as abroad, I want to be sure on Election Day that we're *all alone* in that voting booth. With nobody to tell us, *'Put your X THERE!'* No sir!"

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Republic Building, Cleveland 1, Ohio

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* * *

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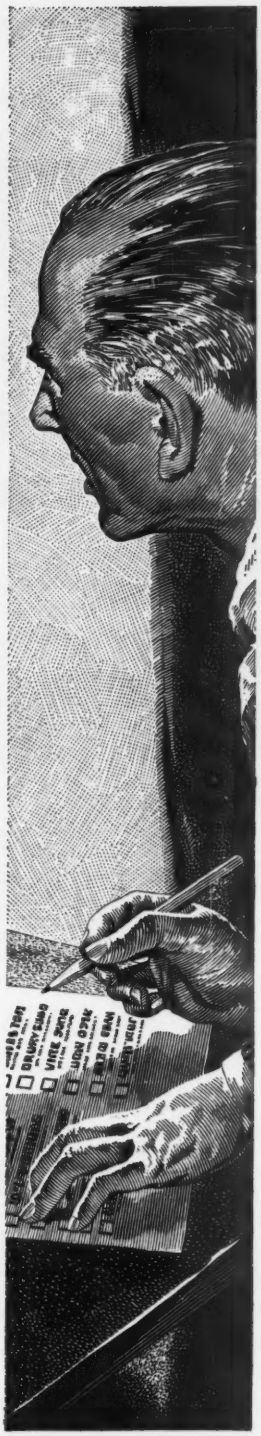

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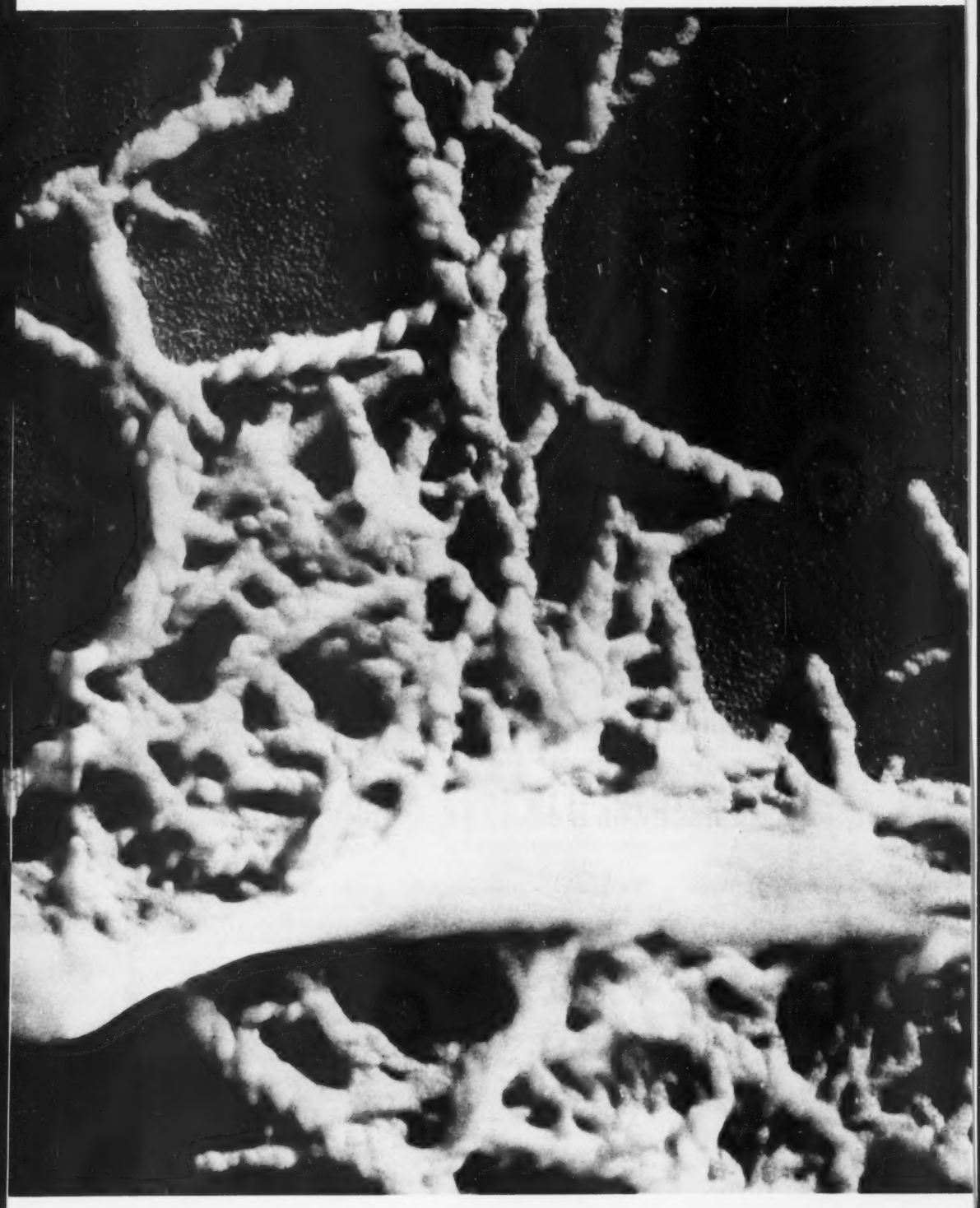
More housing is available in Seattle than in most other major industrial centers. Or, if you prefer the Midwest, similar openings are available at the Boeing Wichita, Kansas, Plant. Inquiries indicating such a preference will be referred to the Wichita Division.

Decide *now* to build your career at Boeing after graduation. Boeing has continuing needs for experienced and junior aeronautical, mechanical, electrical, electronics, civil, acoustical and weights engineers for design and research; for servo-mechanism designers and analysts; and for physicists and mathematicians with advanced degrees.

For further information, consult your Placement Office or write:

JOHN C. SANDERS, Staff Engineer — Personnel
Boeing Airplane Company, Seattle 14, Washington

BOEING



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FRONTISPIECE
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engineering abroad

Living and Working in Bolivia

By Herbert Jacobson, '54

The romance of living in a foreign country combined with interesting work makes engineering in Bolivia a worthwhile experience. It is a comfortable life within a rugged country.

Most of Bolivia lies on a crescent-shaped plateau over five hundred miles in length and bounded by majestic Andean peaks. This tableland lies at an average altitude of nearly 13,000 feet above sea level, while many of the surrounding peaks reach 20,000 feet. The mountains are loftier than any in North America.

Contrary to what might be expected at this altitude, the climate is quite pleasant since Bolivia is in the tropics. The days are warm, the nights are cold, and

The desolate mountains. Majestic and rich in mineral deposits.

cloudy days are rare. Their regular climate is contrasted with our own cold winters and hot summers in the figures given below:

	Boston	*Bolivia (La Paz)*
Mean Yearly Temperature	49° F.	48° F.
Mean Summer Temperature	72° F.	50° F.
Mean Winter Temperature	29° F.	44° F.

Despite the moderate climate, plant life on the plateau is scarce. This is due to the lack of water at high altitude. Natural vegetation is chiefly a kind of moss, called "yareta," and low bushes. Cultivation is limited and is mainly devoted to potatoes and corn.

As a result of this dearth of vegetation, and a wealth of mineral resources, Bolivia's chief industry for over three hundred years has been mining. The industry began when the Spanish "conquistadores" sent home large quantities of silver and gold. These are no longer the leading products. In the last fifty years tin has become the chief product, until at present the country supplies 30 per cent of the world's tin needs. Silver and gold are still produced in addition to varying amounts of copper, bismuth, zinc, lead and tungsten. The mining industry is, therefore, quite extensive and provides opportunities for all types of engineers. Electrical engineers are needed to build hydro-electric and diesel-electric power plants. Mechanical engineers are employed in plant maintenance and operation. This sometimes requires ingenuity, for replacement parts aren't always readily available. Metallurgical and chemical engineers work in the concentrating plants where ore usually containing no more than three per cent of the metal is brought to a purity of nearly 65 per cent. Further purification is done in smelters in the United States and in England. In addition to the above mentioned opportunities there is work for civil, construction, and, of course, mining engineers. Each job presents its own challenging problems created by peculiarities of the land. An example of these problems was the building of a concentrating plant on a mountainside which was gradually sliding into the valley below.

Work in Bolivia is well rewarded. While an engineer's salary is about the same as in the United States it will go further since the cost of living is comparatively low. In addition, one usually gets two weeks of vacation with pay each year and three months' leave at the end of three years. The company also pays for transportation to and from Bolivia and provides a comfortable rent-free home.

A small ore concentrating plant erected on Bolivia's high plateau.

In contrast to these advantages there is one disadvantage connected with the work. This is the fact that working hours can't always be limited to eight. When a breakdown or other emergency occurs the engineer has to be on the job. At times it is necessary to work at night in order to get the wheels of production rolling again.

Both work and play occur against the background of what is commonly known as a "mining camp." However, it's more than a camp. It is a complete town with a population of several hundred. It consists, first of all, of a mine or shaft entrance from which cars loaded with ore regularly emerge. Then there is the concentrating plant where the ore is refined. Sometimes there is a power plant at the camp. In addition, there are repair shops, a company store, offices, a school, huts for the miners and houses for the managers and engineers. A pair of tennis courts and a golf course usually complete the picture. The population of a

The contrast between the miners' huts and the engineers' houses above them, indicates the difference between their respective standards of living.

mining camp in Bolivia is divided into three distinct groups. These are the native Indians, the "meztizos" or halfbreeds, and the whites.

The Indians are, as a rule, the laborers and miners. They are short and strong despite having been born and raised in a rarefied atmosphere and among unsanitary conditions. They chew coca leaves that dull their senses and enable them to work for long periods of time without feeling tired. These people live in a one-room hut without windows or doors. An opening in the wall serves as an entrance. The Indians rarely wash and generally live surrounded by filth.

The half-breeds are better off than the Indians because they usually have a better education and better jobs. The men are the carpenters, truck drivers, and so forth, while some of the women work as ore sorters.

Both Indians and half-breeds are poor compared to the whites, most of whom are foreigners. The whites run everything and live comfortably. They live in homes provided with modern conveniences such as electric lights and hot running water. They also eat better foods and wear better clothes. Consequently, an engineer in Bolivia is resented by the people. This resentment is rarely shown openly for relations between economic groups are, on the surface, cordial.

Inasmuch as living and working conditions are far from ideal, the unions occasionally resort to strikes.

A new whitewashed adobe home for the manager stands on the barren ground.

This typical small Bolivian city surrounded by mountains is the old town of Potosi.

These are apt to be more spontaneous and violent than those in the United States. There have been occasions when engineers were beaten by the workers. This is the exception rather than the rule. Most violence that does occur is due to the fact that the police force is too weak to handle a mob.

Even though work takes up most of an engineer's time he still has many leisure hours. Naturally, the recreational activities in a mining camp are somewhat limited. Tennis and golf provide exercise. In the evenings one can read, play cards, listen to short-wave radio or pursue a hobby. However, evenings aren't always quiet, for lively parties are given on any occasion. In addition, one sometimes can see a movie at the "camp" or in the nearest town, which may be anywhere from ten to a hundred miles away. This regimen of diversion is often insufficient for a bachelor. therefore a job of this type would be more suited to a married man.

Nestled against a mountainside is a tin concentrating plant that operates both day and night.

the russell-dewey controversy

An Excursion Into Philosophy

By Bruce Kellogg, '52

In formulating one's scientific philosophy, it is important to be aware of conflicting opinions and different schools of thought. At Tech there seems to be a noticeable lack of information about the scientific philosophy of John Dewey. This is regrettable, since Dewey is interesting as an heir to nineteenth century thought, in particular, to that of Darwin and Hegel. In this article I shall give a rough sketch of Dewey's scientific philosophy and deal with the controversy between Dewey and Russell on the subject.[1] I shall attempt to show that the fundamental difference between the two does not lie in the definition of truth (as Russell claims), but lies in Dewey's psychological description of scientific inquiry. In addition, I shall attempt to show that the application of cybernetics to human psychology leads to a pragmatic philosophy.

Scientific philosophy today is split into two different schools, the rationalists and the positivists. There are variations of both types, but roughly, the rationalist asserts the existence of a world external to the scientist, and the existence of a number of physical laws governing its behavior. It is the job of the scientist to unravel these laws. The positivist, on the other hand, might remark that man is in fact a part of the universe, his experience is limited, and there are some questions that have no meaning for him. He rejects all metaphysical statements. (By metaphysical statements, I mean statements dealing with the "real" world, as opposed to the world of the sense data.) It is well known that quantum theory has given prestige to this view, and that the Heisenberg uncertainty principle merely says that man is limited in that he receives knowledge *of* the physical world through some sort of interaction *with* the physical world. The physicists Dirac and Philipp Frank are positivists, while Einstein is a rationalist. Dewey is also a positivist, although of a somewhat different sort than Frank. Dewey's brand of positivism is sometimes known as instrumentalism, while Frank's beliefs come under the heading of logical positivism. Russell allies himself with the logical positivists, and in this paper I shall interpret the Russell-Dewey controversy as a split between the instrumentalists and the logical positivists.

Dewey's philosophy depends strongly on his psychology, which is a form of behaviorism. Professor Deutsch, in a very interesting paper,[2] uses Wiener's work on feedback mechanisms to develop a theory of man; man as a very complicated switching mechanism with a built-in feedback. It is this feedback that gives man his autonomy. The big drawback of the classical mechanistic model of man was that it did not explain man's consciousness and feeling of free will. The novelty of Deutsch's work lies in the fact that, using the feedback mechanism, he does explain these two feelings. The feedback enables him to change his course of action if previous actions were not furthering his goals. There is the possibility of changes in the goals sought for, and by feeding back information on the internal state of his mind, man (or Deutsch's model of man) does achieve a sort of consciousness.

The essence of the feedback mechanism lies in evaluating a course of action by the results it produces and changing it accordingly. Thus the germ of pragmatism lies latent in Deutsch's paper and in the work of Wiener in applying cybernetics to the human brain. Later I shall expose the striking similarity between Deutsch's and Dewey's models of man, and show how Dewey's logical theories fit Deutsch's man.

Dewey places man in a biological and evolutionary matrix. Viewed as a biological animal, man must strive to stay alive and to reproduce his race. He is subjected to a series of experiences from the outside world, and he must learn to cope with these experiences. Thus man's basic activity is the solving of problems, and all of his intellectual creations must eventually refer back to the fundamental facts of his existence. Scientific inquiry is merely inquiry into man's environment abstracted to such a high level that the scientific problems no longer are to be solved to gain specific ends, but rather, when solved, will give general instruments or means for attaining a variety of ends.

From this it is clear that Dewey actually *is* a positivist. As a human being he accepts himself and his environment. The environment is what it is because of its relation to man, and there is no question of independent metaphysical existence of the environment. Dewey's is a man-oriented philosophy.

Man engages in inquiry on a number of different levels. Dewey asserts that there is a common pattern which lies behind all of man's investigations. Viewed as an organism, man is confronted with a problematic situation which he does not understand. He is, as it were, irritated by a certain situation in his environment. He must first formulate the problem in his mind. The formulation of the problem, in itself, is a partial solution, and is a major step toward solving the problem. The formulation occurs in some sort of language, and thus, for Dewey, language is essential for the solving of problems, or, what is the same thing, for any kind of thought. The formulation suggests experiments, which in turn may suggest further modifications in the formulation. The whole process constitutes a reordering of experience, both on a physical (experimental) and on an intellectual level. The solution comes when the original situation is resolved and understood, and the phenomena involved can be predicted.

In the above description, observations and ideas unite in the resolving of the problem, the former in stating the problem and testing hypotheses, and the latter in pointing toward the solution. With respect to the process of inquiry, both facts and ideas are purely functional, they have a certain role to play in attaining the solution to the problem. But a fact in isolation has no meaning. "Facts are evidential and are tests of an idea in so far as they are capable of being organized

(*Continued on page 16*)

1. See the chapter on Dewey in Russell's *History of Western Philosophy*.
2. "The Role of Models in the Natural and Social Sciences," in *Synthese*, vol. VII, p. 506.

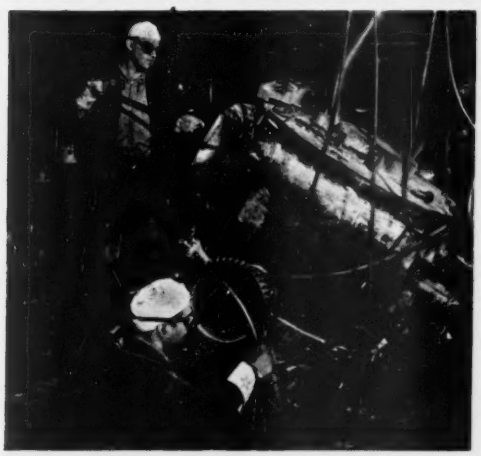
the metal industry looks to powder

An Old Process Meets New Needs

By Norman R. Gardner, '53

The application of metal in powder form to the manufacture of parts is rapidly taking its place among high speed production practices. In many ways it resembles the growing stages of the firmly established die-casting industry. Although it may never approach the magnitude of die-casting, it is a comer, and a fast one at that. Already the metal powder industry is over the two hundred million dollar mark and well on its way up.

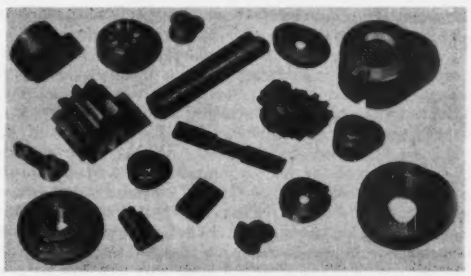
The scope of the powder method can be divided into two main categories. One is the production of items which cannot be realized by any other process. The other is the manufacture of articles which are being made by die casting, precision casting, forging, and other present day processes. Probably the best known of the first group is the so-called "oil-less bearing." The nature of the powder part, which will be discussed below, is such as to facilitate the free circulation of the lubricant through an interconnected pore system. The oil is brought to the surface by heat expansion and centrifugal action. A more recent innovation is the inclusion inside the oil-less bearing of a cavity which increases the oil content five or six times. Refractory metals, such as tungsten and molybdenum, provide a highly significant application for powder metallurgy. The conventional fusing operations are not very feasible with these metals, since they have melting points of 3,300° and 2,600° C. respectively. They are used extensively in incandescent lamps, electronic and x-ray tubes, and furnace heating elements. Surgical instruments and chemical appliances made of tantalum have also found wide application to the development of metals of high ductility. The application of the refractory metals in carbide form has made possible excellent cutting tools and wearing parts for the machine industry. So much for some of the items that the powder process can call its own.



Courtesy New Jersey Zinc Company

Metal powders made by blowing high pressure air against streams of molten metal.

The competitive market for the manufacture of many machine parts is slowly turning towards the powder process due to some or all of the many advantages that it makes possible. For instance, casting, even centrifugal casting, has not as yet been able to produce an item in which the alloying metals and non-metals are uniformly distributed. The powder process offers a far greater degree of control of particle size, distribution, and the subsequent properties of the part. The costly machining operations which often follow the casting method are eliminated or greatly reduced, and the amount of scrap is almost negligible.



Some typical powder metal parts.

However, it would be well for us to consider some of the major limitations to the advance of the industry. To begin with, the powder method is new and therefore will have to prove itself. The powder industry must make information available about the proper place that powder methods have in the metal field. This function should be performed honestly and the possibilities of the process should be put in their proper perspective. The development of more supporting data for the process is sorely needed, as is the transfer of existing information. The high cost of equipment and the need for quantity production to offset the prices of dies, which range from one hundred to two thousand dollars, is also a formidable obstacle. Finally, the need for applied and basic research is very great.

Probably the oldest method for preparing metal powder is the reduction method. This dates back three thousand years, and is not playing an active role in this rejuvenated industry and science. In ancient times the method was a culmination of necessity, rather than a need for improved products. Many years ago furnaces were not known which could melt the various known metals. The primitive method used in the extraction of iron, for instance, consisted of heating the iron ore in a charcoal fire — fanned by the air blasts from bellows — until reduction of the oxide was

(*Continued on page 22*)

transit for the future

M. T. A. Builds East Boston Extension

By David L. Klepper, '53

On January 26, 1940, Boston lost a railroad. For over sixty years the Boston, Revere Beach and Lynn had transported commuters to and from its East Boston ferry slip. For most of the "Narrow Gauge's" existence its patrons rode nineteenth century coaches pulled by quaint steam engines; for its last twelve years the railway was electrified with traction motors installed in the old coaches. Its owners' dreams of a building boom did not materialize, however, and the railroad could not meet highway competition through the then-new Sumner Tunnel. Despite petitions and protests from its regular patrons, the line was abandoned.

Traffic to Lynn was divided between the steam train of the Boston and Maine and the orange buses of the Eastern Massachusetts Street Railway. Nearer to Boston the only transportation available consisted of the Orient Heights-Revere Beach streetcars of the Boston Elevated Railway, now the M.T.A., and the small buses of the Rapid Transit Co. to Winthrop, all feeding the East Boston Tunnel Rapid Transit line at Maverick Station. Riding was fast from downtown Boston to Maverick, but then the homebound commuter would be faced with delays as overcrowded streetcars and buses picked their way through narrow, congested streets. During and after the war more people began to settle in the area; this, traffic congestion, and lack of parking space in downtown Boston meant more people using the overcrowded surface transit lines. Something had to be done to improve the mass transportation facilities. The extension of the East Boston Tunnel line from Maverick Square northeast to Orient Heights was proposed in 1945, and in 1946 work started.

Before looking over the extension itself, let us examine some of the features of the original line. The East Boston Tunnel was originally opened for streetcars in 1904; only in 1924 were high station platforms and third rails installed for rapid transit cars. Because of its position under the Boston Harbor, the Tunnel has not been enlarged or changed in alignment; consequently, clearances are very restricted and the rapid transit cars operating in it are the smallest in this country. Most restrictive is the turn-around loop curve at Bowdoin Station, the eastern end of the line.

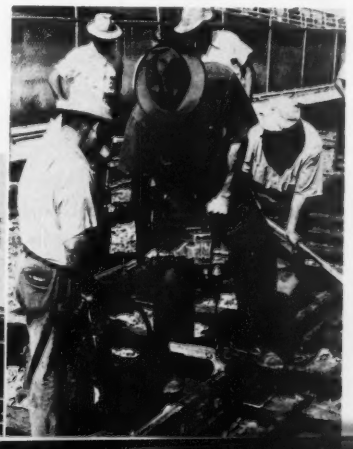
Unlike both the Cambridge-Dorchester Tunnel and the Elevated, the East Boston Tunnel had constructed no extensive repair facilities. A storage tunnel and its extension into a small maintenance shop were constructed in 1924, but major repairs had to be handled at the Harvard Square Shops of the Cambridge line. For this purpose the old trolley line from Bowdoin Station down Cambridge Street and across the Longfellow Bridge to a switch not far from Kendall Station has been used as a service connection. The sight of a rapid transit train with a man standing at the rear door holding a temporary trolley pole to the wire for powering the third rail cars, right on the north roadway of Longfellow Bridge, has surprised many a late night cab driver or motorist. The construction of extensive repair facilities will put an end to such unorthodox proceedings.

The new extension starts out through the old storage yard and maintenance tunnel. The new concrete tunnel retains the impressions of the boards used in forming it. At Grove Street the tunnel curves to the right, passing under private property, Bremen Street, the Boston and Albany Railroad Yard, Porter and Orleans Streets; and, after curving to the left, it emerges into an incline running to the surface near Airport Station.

North of the station the double track line parallels a new express highway and the B. & A. yards. Portions of two buildings had to be demolished in order to construct a temporary reverse curve. Eventually the Airport is to be extended to the land on which these buildings rest; at that time they will be completely destroyed and the curves will be replaced by tangent track.

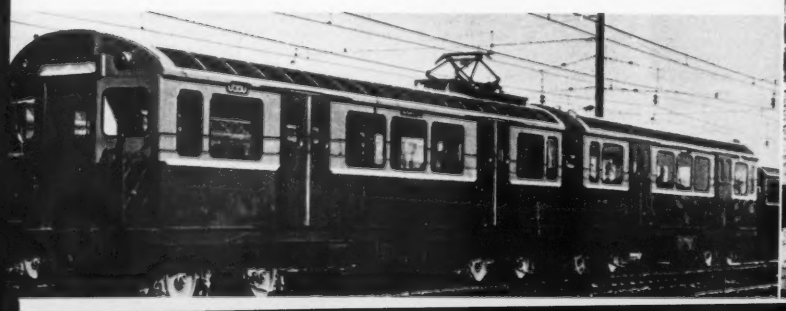
North of the station we find a tower housing the interlocking machine which controls all automatic switches and home signals. This machine is of the miniature lever type, with a track diagram of the entire extension. Glowing colored lights spot the location of every train north of Maverick Station; lights of other colors show signal indications and positions of switches. All switches and signals will be interconnected by relays, so that a signal governing train movements over any part of the interlocking territory cannot be cleared until all switches are in proper position and locked and all signals governing conflicting movements are properly displaying the "stop" indication.

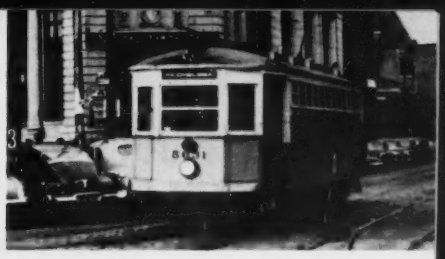
The entire length of the extension not in the inter-



Right: **Track workers employ compressed air-driven drills and screw pike drivers.**

Below: **These new grey and red rapid transit cars for the East Boston Tunnel are standing at Orient Heights Yard.**





Streetcars battle traffic through East Boston on their way to Maverick Station.

Airport Station has two-track platforms and an elevated bus platform. Temporary wires are up with hangers for permanent catenary.

locking territory will be protected by forty-three automatic block signals. At each signal there is an electrically controlled, compressed air operated train stop. When the signal is red, this train stop will activate the brakes of any train passing over it. The block signals are operated in one direction only on each track and are designed for a minimum train spacing of ninety seconds. Each signal will display a stop indication as soon as the front end of the train passes it, although the action of the train stop will be delayed. If a distance equal to that required by emergency braking from full speed plus fifty per cent is provided by the following train, there will usually be two red signals between trains. Following signals will display yellow, then green.

Speed control timing will be superimposed on the block signal system as required. At grades the train will approach a yellow over white signal. If the speed of the train is proper, the signal will clear to green as the train approaches; but if the train exceeds the posted rate the grade time indication will continue, and the next signal will indicate stop for a time sufficient to either force a reduction in speed or cause the train to be automatically stopped. At station approaches the train will first arrive at a signal displaying red if there is a train standing in the station. If the speed of the train is reduced to the posted rate the signal aspect will change to yellow, allowing the train to proceed to the signal immediately behind the train in the station.

Several control circuits are needed for a signal system of such complexity. Track circuits, to determine the presence of a train in the block, are A.C., polarized, twelve to sixteen volts, with two element track relays operated by 110-volt A.C. Stop control circuits are sixteen volts D.C., rectified. The lights themselves burn on A.C., ten volts. Power supply is by 575-volt single phase lines.

Contained in this 2.1 mile extension is approximately 45,000 feet of single track, switches and crossings on the main line roadbed and in Orient Heights Yard. Above the roadbed lies broken stone ballast, supporting treated ten-inch wood ties, spaced two feet on centers. Rubber composition pads rest under the steel plates that support the rails, reducing cutting of the ties to a minimum. The rails themselves weigh eighty-five pounds per yard; all their joints are welded except at switches and insulated gaps for signalling circuits, a new practice in rapid transit construction.

All main line curves are designed with easements at each end and are superelevated (the outside rail raised) for varying speeds between thirty and forty miles per hour; the length of the easement was determined from the superelevation, giving a run-off of one and one-quarter inch per second wherever possible.

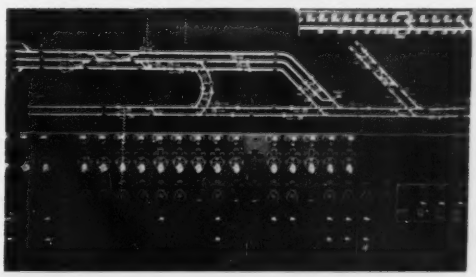
Guard rails are used on all curves. They are the same type as the running rails; however, they are set in a horizontal position thirteen-sixteenths of an inch above the running rails' surface, and their base is planed off one and one thirty-second inch to clear the car motors. The required flangeways can be maintained at all times by adjusting the positions of the guard rails on their supporting braces spiked to every other tie.

All switch point assemblies are made up of a single straight point and a double curved point, constructed of regular 85- and 100-pound rail. The double point acts as a guard rail when the switch is in the normal position. In the yard, where traffic is lighter, regular No. 5 switches are used. All frogs are of manganese steel and are interchangeable.

Construction of the track began from both the Maverick Square end, in the tunnel under Chelsea Street, and the Orient Heights Yard. For the project a number of work cars have been brought out to the extension; these consist of three air compressor cars, all rebuilt from old streetcars; two steel bottom dump cars; two steel side dump cars; and a crane car. Outside the tunnel the current distribution system will consist of a 4/0 A.W.G. grooved bronze contact wire suspended by hangers from catenary messenger wire consisting of four strands of copperclad steel and fifteen strands of copper. This suspension wire has a sag of definite mathematical proportions and the hangers are of such length as to produce a contact wire parallel with the rails.

(*Continued on page 24*)

Lights on the track diagram indicate position of switches and their home signals, as well as location of trains. Switches below control all track switches and home signals.



the motion of the earth

Some Extra Curves Thrown In

By John Mathis, '53

Things are never so simple as they seem. We are all aware that the earth is in motion about the sun and about its own axis as well. We assume unthinkingly that the rate of the earth's rotation is constant and base our time scale upon it. We think of the succession of nights and days as endless and unchanging. We seldom realize that some phases of the earth's rotation have changed within recorded history.

Most of the ancients never suspected that they were constantly in motion. They had every reason to believe that the position of the earth was fixed in the center of the entire universe and that the sun, stars, and planets revolved about it. The Greek scientist, Aristarchus, was about the first to set forth the bold doctrine that our planet is not the kingpin of the cosmos, but he was never taken seriously. The scholars who advanced the heliocentric or sun-centered theory of the solar system in the Middle Ages suffered severe persecution and punishment for their views. However, Copernicus introduced the theory because it made involved astronomical calculations simple, not because of direct observations of rotational effects on the earth itself.

The heliocentric theory did save many laborious calculations, but it had one big drawback. Copernicus couldn't explain why the fixed stars didn't show any parallax, or difference of direction in summer and winter. When you move your head, the nearby objects appear to move relative to the background; when the earth moves about the sun, the nearer stars should move relative to the very distant ones. Astronomers looked in vain for any such displacement. Copernicus was vindicated in 1838, when the mathematician-astronomer Bessel first observed the parallax of the stars. At the present time, modern measurements of angles have enabled astronomers to observe the parallax between hundreds of stars. Measuring parallactic angles now is like standing six feet from a three-year-old child and measuring how much he grows in forty minutes.

Those early astronomers could have demonstrated the earth's rotation directly if they had set a pendulum in motion. The pendulum tends to maintain the same direction in space, and the earth rotates under it. The period of the pendulum's rotation is dependent on latitude; on either pole the earth obviously rotated under it once each day, while on the equator, there is no apparent rotation. Generally speaking, the period is one day divided by the sine of the latitude.

The earth's rotation has had some effect on the shape of the planet. The centrifugal force due to the rotation caused the plastic material of the cooling mass to bulge out at the equator some twenty-seven miles. This force is also responsible for the curious fact that the source of the Mississippi River is several miles closer to the center of the earth than its mouth is. If the earth were to stop spinning, the Gulf of Mexico would flow into Minnesota!

Fortunately for us, the axis of the earth is not directly perpendicular to the plane of its orbit, but tilted at an angle of twenty-three degrees. This tilt causes the Northern Hemisphere to receive sunlight more directly for half the year than the Southern. The change in angle of the received light, not the distance from the sun, causes the seasons. Although the sun is most nearly vertical on June 21 in the Northern Hemisphere, the hottest days occur a few weeks later, when the sun has warmed up the lower atmospheric layers.

Our days are also getting longer, although it will be some time before we can reasonably demand four meals a day. The earth encounters little friction as it swings through space, but it has to rotate under the tides in the ocean. The tidal friction is huge compared to ordinary standards; it is working to stop rotation at the rate of two billion horsepower. Yet this terrific expenditure of energy will lengthen the day only one second in about one hundred fifty thousand years! This slight deceleration has even been measured directly; ancient but accurate records of eclipses indicate that the increase in our day is about one second per hundred thousand years.

Although the ancients were unaware of the earth's rotation about the sun and its revolution on its axis, they did observe one of its far less obvious motions. Various Greek astronomers noticed an apparent shift of the North Star. They determined that the direction of true north was rotating very slowly but regularly. They called the period of the rotation the "Year of the Gods" because they believed that a man's lifetime was a god's day, and the period is almost exactly three hundred sixty-five multiplied by seventy (about twenty-six thousand) years. Although they did not understand the causes of this change of polar direction, they were amazingly close to the correct period.

Modern astronomers can explain the precession of the axis very easily. Like any other spinning object, i.e., a top, the earth tries to maintain a constant direction of rotation. However, the sun, moon and planets attract the equatorial bulge more than the poles. The resulting torque causes the spinning earth to wobble or precess about its axis, exactly like a top does when tipped slightly. The axis is always at the angle of twenty-three degrees to the plane of the earth's orbit and slowly generates a cone with the earth at the apex. Of course this precession is quite noticeable over recorded history; when the pyramids were built, the pole star was Alpha Draconis, which is twenty-five degrees from the present star, Polaris. Furthermore, the precession means that the base of astronomical measurements, the plane of the earth's equator, is constantly shifting. That is, every astronomical measurement must bear the date of observation in order that corrections can be made for the change in coordinate systems.

There are even more complicated corrections that must be made for very precise measurements. The earth seems to be nutating, or bobbing up and down in the slow precessional swing of its axis. The period of this nutation seems to be about nineteen years, but the motion is so slight that little precision can be obtained in measurements. To make the matter even more complicated, the axis seems to be shifting in the earth itself. The poles move annually over a circle of about forty feet in diameter. This means that the latitude and longitude system of the earth shifts slightly throughout each year. These many complications make even the precise locating of a star a very nasty mathematical job. We need another Copernicus today.

ostheimer's rule

(*Continued from last month*)

By Rudolph W. Preisendorfer, '52

Herrmann Ostheimer, retired pioneer of space flight, was resting, remembering his achievements, and his failures. He thought of the first time he met Nikkersson, that unassuming little professor, the man who developed the idea which promised to revolutionize space flight: the Nikkersson Drive, which whisked ships almost instantaneously from planet to planet. Ostheimer remembered the first time the idea was tried: A trip to the moon. The experiment ended in a gigantic explosion as soon as the ship reached its destination. The second try likewise ended in failure; and the third. But finally Nikkersson announced that he had found the trouble. A new trip was planned.

"Why not try for the stars right away?" argued Ostheimer. "Everything in its turn," Nikkersson would reply; besides, the full operating knowledge of the drive was still not known. It was really sheer folly to make a trip to Mars in the first place. But Nikkersson would chance it. He chanced it and failed. Three hundred and ninety-seven seconds after Nikkersson's departure, the Rockerfeller reflector on Mount Shasta, which had been specifically trained on the planet that night of the launching, recorded a brilliant flare just inside the southern polar cap.

Ostheimer stood up, stretched, and flexed his old arms. Still standing, he reloaded his pipe methodically and abstractedly, still under the spell of his recaptured youth. The morning had aged to noon, and shadows hid directly under the Pop-bean trees and nestled coolly among the Havernut bushes that ringed the cottage.

"Now if I only had thought it out sooner," he mused — "but that was not destined to be. I had to kill Charley, Leith, Bakerson, and their crews before it dawned on me just what really was going on. I had to plunge the whole world into a period of mistaken, dark despair by blurting out a falsely deduced conclusion." He sat down again in the chair, and wearily lifted his legs on the white railing. "It all seemed so logical at the time, though," he continued to recall. "Charley Markshon and three men went up in the fall of 2009, and made a successful trip to and back from Mars, but they never landed there. The next week, Markshon went up again and circled Jupiter in one power run that carried them out and back, and when they landed, half of the Mohave Desert went up with them." It was a strange bit of foresight, possibly an unconscious heralding of the final solution to the whole problem, that made Ostheimer pick the Mohave as terminus for the flight. But still, he recalled bitterly, he didn't recognize the final truth. Leith and Bakerson went out, one after the other, and never returned. That was two more years, and six more lives, and millions more of dollars, and more shattered dreams, all leaving behind a bitter sense of impending hopelessness. The government, despite its large research allotments, would tolerate this loss of men and money no further. Leith and crew went up in atomic flame as he brushed the gaseous shell of Jupiter. Bakerson, in the spring of 2011, gashed a brilliant path of pure energy and light down into the woolly white atmosphere of Venus. What else could he have concluded? The facts all pointed to one astounding and mortifying revelation: That Earth, by some enormous freak, had been conceived as a contraterrene planet. It was this that he postulated and announced to the world on that dark April morning in 2011. The masses accepted the fact with an intellectual docility and complete belief that had been developed during the twentieth century, as far as scientific achievements and discoveries were concerned. Others, notably the astronomers and physicists, were violently at odds with the deduction, and offered reams of proof that the postulation was incorrect. But Ostheimer remembered their faces when he mutely pointed to the planets, and reminded them of the results of the contacts with Earth-made ships.

It would be hard to describe his thoughts and feelings during the few weeks after the announcement.

But somehow a feeling of complete futility and total loss spurred him on to that momentous decision that led the way to the resolution of the problem and to totally unexpected new corollaries. The feeling of futility was understandable, but the loss-feeling was peculiarly his own. He had tasted the wine of instantaneous interstellar travel; his horizons were expanded by the potentialities of the Nikkersson drive, and the loss of this mode of transportation would be overwhelming. He could never, never again consider a simple, slowly plodding chemical or atomic drive, neither for use to the planets nor the stars. It would be best to describe that sensation as one of claustrophobia . . . hemmed in, yes, that was it.

On the morning of February 6, 2012, the silvery spherical ship, which he had never bothered to name, stood quietly at rest in its cradle. The crisp morning air was perfectly motionless, as if it too sensed the enormity of the coming event. The sun glowered redly in the East and a silver half-moon looked straight down unconcernedly upon the desert scene.

(*Continued on page 30*)

tech engineering news

Professional Journal of the Undergraduates of the
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The Managing Board expresses its regret that Charles Lenz, Art Editor, will not be able to return to the Staff until February.

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from the editor's notebook

Can you remember the first written test you ever took in school? Or, for that matter, your twenty-first? I'm pretty certain that you can't. You'll agree, then, that you've taken quite a substantial number of them. But, what for? Yes, I know the obvious answer: to get a grade. But, what actually were those exams trying to find out, and what should their purpose have been?

We've all taken exams in geography at one time or another; the type where we were asked what Milwaukee is noted for, and supposed to answer "grain elevators," or something (we know better now). Weren't those tests a little silly? What do we remember about the subject matter now? Not much, if we are to believe the results of the *New York Times* questionnaire on geography, filled out by college students throughout the nation. Those old geography exams, then, succeeded in measuring nothing but the ability to memorize disconnected facts, and to retain these for a few hours. Certainly, there can be very little justification for this procedure, especially since facts, where needed in actual practice, can so easily be checked.

What, then, should the purpose of an exam be? It would be wrong to say that all exams should try to test solely the student's reasoning ability, for we would then face just a succession of intelligence tests. Yet, the idea has some appeal.

Suppose we turn to industrial leaders for the answer. I have before me a poll taken of the engineering heads of various aircraft manufacturing companies, published in the September 1951 issue of the University of Alabama's *Engineering Magazine*. The results seem to be typical of what you would expect from industry in general. The following quotation from one company seems to sum up prevailing opinion quite well:

"In general, the emphasis should be placed on fundamentals and how to think. There are too many engineers who want to substitute testing for thinking, and too many who know procedures and formulas but are not well grounded on the fundamentals."

In other words, each course should be aimed at developing certain fundamental concepts. These should be thoroughly assimilated by the student. He should then be tested on his ability to apply these principles to different problems, to situations which he has not seen or thought about before.

It is disturbing to note that many courses and exams at M. I. T. seem to approach the level of our geography test. This is a tendency which should be stopped. One of the most effective means of doing this would be to encourage the open book test. A course which would require complete revision in order to make it suitable for open book test is, in all probability, one which should have been revised or dropped long ago.

We must assure ourselves, if the reputation of this school is to be maintained, that we are not turning out walking filing cabinets, or encyclopedias, but thinking human beings.

S. K.

About Our Authors...

Herb Jacobson's father has spent some time working in Bolivia, and so **Herb** had a source of firsthand information on which to base his article. **Bruce Kellogg** is a senior in Course XVIII, but as you can see he has quite a wide range of interests. **Dave Klepper** has written a number of articles on different aspects of the Boston transportation system. Here he continues the series. **John Mathis,** our Literary Associate, can always be depended upon to turn out an interesting article. I think you will agree that this one is quite unusual. **Norm Gardner** is a junior majoring in Metallurgy. Here he puts his knowledge to good use.

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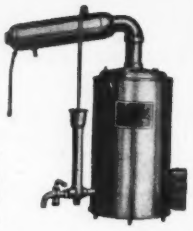

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russell-dewey controversy

(*Continued from page 8*)

with one another. . . . When the problematic situation is such as to require extensive inquiries to effect its resolution, a series of interactions intervenes. Some observed facts point to an idea that stands for a possible solution. This idea evokes further observations. Some of the newly observed facts link up with those previously observed and are such as to rule out other observed things with respect to their evidential function. The new order of facts suggests a modified idea (or hypothesis) which occasions new observations whose result again determines a new order of facts, and so on until the existing order is both unified and complete. In the course of this serial process, the ideas that represent possible solutions are tested or 'proved.' "[1]

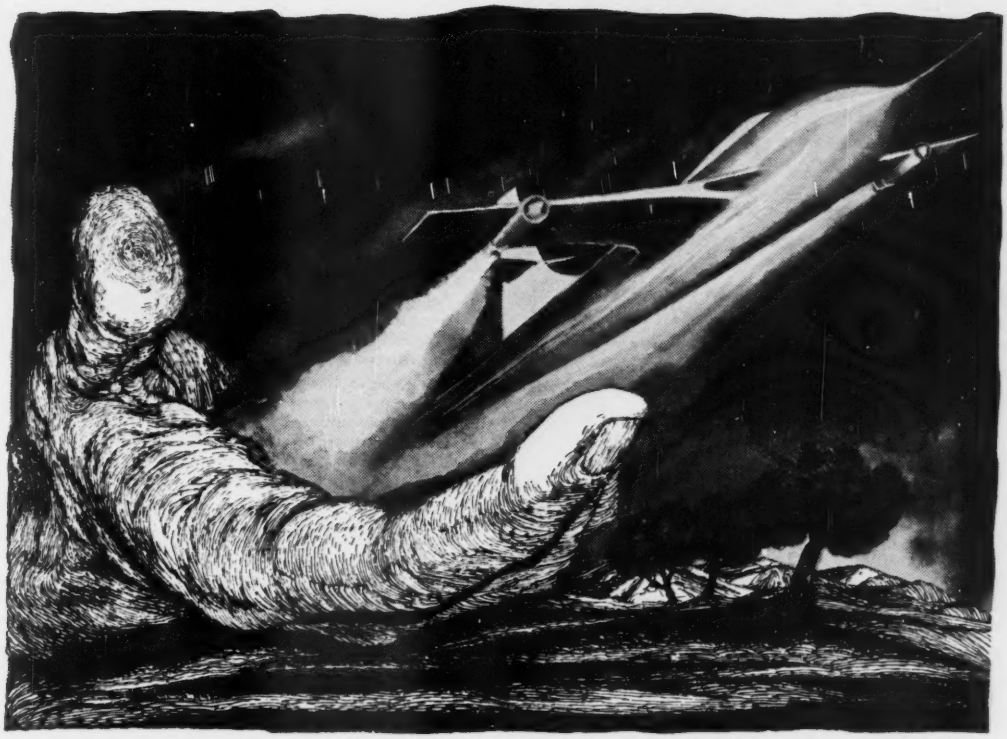
This quotation shows Dewey's debt to Hegel. The process he describes is almost dialectical. But also, in the dialectical search for resolution of the problem, possible intellectual solutions are tested by experiments and modified accordingly. This whole process is very similar to the workings of a machine with feedback mechanisms. Wiener[2] describes the possible operation of a chess playing machine which learns the subtleties of the game by playing against good opponents and learning by its mistakes. Such a machine (which thinks and has a consciousness as described by Deutsch) would follow closely the psychological pattern of inquiry described by Dewey. Hence Dewey's logical theories and his theories of value would apply to such a machine. If man is in fact a cybernetic mechanism, it follows that, by his very nature, he is a pragmatic creature.

According to Dewey, the end of inquiry is the resolution of a previously indeterminate situation into an understandable, unified whole which fits into the background of previous experience. Russell criticizes this and asks what Dewey means by a "unified whole." For Russell the words "unified whole" seem to imply the whole of the inquirer's experience. Anyone who plays chess knows what Dewey is trying to say here. Very often, in the process of a chess game, a situation develops, a local concentration of power which may threaten important pieces or jeopardize a position. While one must not neglect other parts of the board, such a situation is usually reasoned out by itself. Also, the resolution of the situation usually leads to other situations, and the game may be considered as a sequence of continuously changing situations whose boundaries merge into one another. It should be clear that Dewey is trying to describe a definite psychological state.

Dewey tries hard to fit mathematics into the above scheme and, like his predecessor Hegel, gets into difficulties. He interprets the whole of mathematics as

1. Logic: *The Theory of Inquiry*, Dewey, p. 113.
2. In a talk given at M. I. T.

(*Continued on page 18*)



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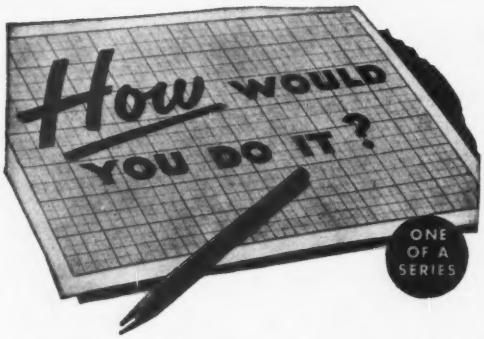

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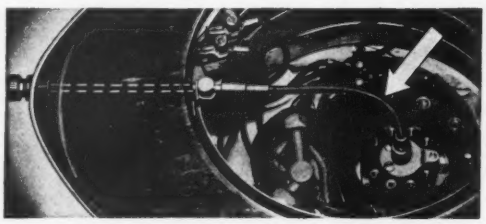

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russell-dewey controversy

(*Continued from page 16*)

having a strictly operational or functional role to play in the process of inquiry. He even discards the definition of number in terms of classes and says that a number must be considered as purely operational in character. He seems to realize the tautological character of mathematics. Yet in trying to make mathematics operational he becomes misleading. For example, the principle of induction "is in fact a formulation of the inherently recurring nature of any operation until it is intercepted by combination with another operation or is delimited by a field like the transfinite numbers in which operations do not have the inductive property."[1] Quite aside from not having heard of transfinite induction, he seems to think that ordinary inductive proofs can be performed for reasons outside the sphere of mathematics, which, of course, is not true. The law of induction is subject to proof like any other mathematical theorem.

Dewey holds that inquiry (or any form of thought) can not be carried out without a language in which the inquirer can formulate his problems. It would be much better for Dewey if he simply held that mathematics is merely a particular development of the language, purely formal in character, and is applicable to inquiry in the same manner as the rest of the language, and omitted any other remarks on the character of mathematics. This would not interfere with the other phases of his theory, would make it clearer and more correct, and would render it palatable to mathematicians.

A cursory examination must now be given of the position of logical positivism. For the logical positivists, physical knowledge consists of a system of relations between symbols (e.g., Maxwell's equations for electromagnetic fields) plus semantical rules from which statements about observable facts can be derived. These systems have been investigated in a formal manner by Carnap.[2] A semantical system, in the sense of Carnap, is a language and a system of rules referring to the language, such that the rules determine a truth condition for every sentence of the language. Thus a physical theory is no more or less than a semantical system. Its validity is measured by the correctness of the statements concerning observable facts which can be derived from the theory. The advantage of this concept of a physical theory is that the theory need not be concerned with observable facts directly, as in the case of quantum mechanics.

As in the case of the instrumentalists, it is necessary to remark that the logical positivists are in fact positivists. The essence of their epistemology is that the meaning of a proposition is contained solely in the implications the proposition carries concerning observational facts. Thus, if someone remarks that there is a "real" world lying behind the world of the sense data, the logical positivist would immediately inquire as to what difference it would make if the statement were false. If it would make no difference whether the statement were true or false, then for the logical positivist, the statement is meaningless.

Now we are in a position to probe into the difference between logical positivism and instrumentalism. In so far as the product of inquiry is a complete well-rounded theory from which predictions about real events can be

1. Dewey, op. cit., p. 408.
2. Carnap, *Introduction to Semantics*.

(*Continued on page 20*)

THIS MIDGET TUBE WAS A MIGHTY CHALLENGE

It had Bell Telephone engineers scratching their heads.

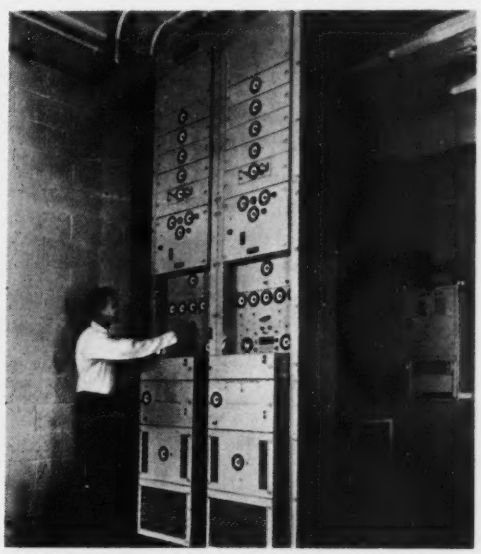
A new kind of electron tube was needed for coast-to-coast *Radio-Relay*. It had to amplify a wide band of super-high-frequency signals. It had to relay them, without distortion, every thirty miles across the country.

That meant splitting hairs. For the working elements of the new tube would have to be five times closer together than in any other tube. And that's mighty close — 6/10 mil between grid and cathode; grid wires 1/3 mil thick, and wound a thousand to an inch.

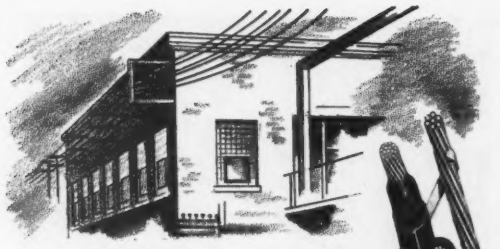
What's more, the tube had to be designed for assembly-line production, then installed and maintained, and its performance on the job analyzed.

The walnut-size midget was developed and the first samples were made by scientists in the Bell Telephone Laboratories. It was a joint project, involving electrical, mechanical and chemical engineers, and skilled ceramic, metallurgical and other technicians.

Quantity production of the (416A) tube was a job for Western Electric, the manufacturing unit of the Bell System. Work had to be done under microscopes. Western's engineers designed new equipment, worked out details of assembly, devised ways to develop skillful workers, simplify operations, keep assembly areas surgically clean.



Engineers in the operating companies and A. T. & T.'s Long Lines Department continually study the performance of the "Mighty Midget" as it plays its part in speeding telephone calls and television programs across the nation. From their studies will come more challenging problems for—and more solutions from—Bell System engineers.



How to lick dust, moisture and acid fog

prevalent in the atmosphere surrounding the Rumford, Me., mill of the Oxford Paper Company posed a problem in power circuit maintenance. The combination of these elements caused wooden structures and even over-voltage insulators to become conducting, resulting in phase-to-phase flashovers and burndowns when ordinary overhead wires were used.

The solution of this serious problem was found by substituting Okolite-Okoprene Self-Supporting Aerial Cable for the open wires. According to company officials, the combination of Okolite high voltage moisture and heat resisting insulation, protected by non-conducting weather and chemical resistant Okoprene sheathing, has eliminated this trouble.

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OKONITE insulated wires and cables

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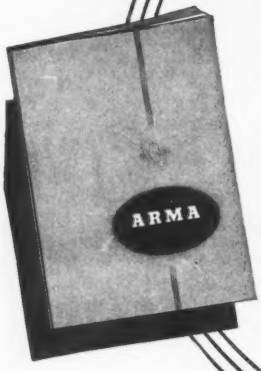

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QUALITY ARMA INSTRUMENTS PRECISION

russell-dewey controversy

(*Continued from page 18*)

made, the logical positivists and the instrumentalists are in accord. The main disagreement comes in the meaning attached to the propositions used in inquiry. Dewey's logical theory arose from his study of the process of inquiry and his form of behaviorism. He holds that the meaning of propositions is contained entirely in their function in the process of inquiry: in so far as they help attain the goals of inquiry. On a broader scale, the value of anything is determined by how much it helps the attainment of certain goals. These goals arise out of the psychological needs of the individual and are ultimately the goals of survival. This judgment of means with respect to the ends they produce is precisely what is meant by pragmatism. Now we see the real relationship between pragmatism and logical positivism. The pragmatist or instrumentalist is a positivist with something added. He is a positivist *and* a behaviorist of the Dewey variety. He holds certain views concerning the psychology of man and his biological matrix, and it is these views, not his positivism, that characterizes him as a pragmatist. Thus the refutation becomes a psychological, not a philosophical problem. It is by virtue of this that the holding of certain psychological opinions forces the cyberneticist to accept the pragmatic philosophy.

Almost all of Dewey's technical criticism of the logical positivists depends on the point made above, since this criticism depends on Dewey's concept of the process of inquiry and his concept of the *meaning* of a proposition. Thus, when he says that data isolated from the context of a particular inquiry has no meaning, he is making a psychological, not a logical statement. For Dewey the statement is logical, but this is because his logic is conditioned by his psychology; for an outsider, a logical positivist, the statement is psychological since it is held by virtue of his psychology.

There is a criticism by Dewey that is relevant, even after his psychology has been rejected. In the preface to *Introduction to Semantics*, Carnap says, "While many philosophers today urge the construction of a system of semantics, others, especially among my fellow empiricists, are rather sceptical. . . . They are afraid that a discussion of propositions — as distinguished from sentences expressing them — and of truth — as distinguished from confirmation by observations — will open the back door to speculative metaphysics, which was put out at the front door." Dewey is one of the "fellow empiricists" who believes that this is the case. For him, all logical forms are instances of a relation between means and consequences in a properly executed inquiry. Through a period of time, as inquiry changes and science delves deeper into more fundamental matters, logical forms must be free to change and develop also. He is of the opinion that the rigid semantical forms constructed by Carnap, while not metaphysical, amount to nothing less than a stagnation of logic, with consequences as inhibiting for the development of science as the Aristotelian stagnation of logic. A fundamental thesis of Dewey's is that logical forms accrue to subject matter when the latter is subjected to controlled inquiry. The reasoning of the logical positivists bears this out since their logic arose from a study of mathematics and quantum mechanics. Nevertheless, Dewey claims that allowance is not made for further development of logical forms. Whether or not this is true remains to be seen.

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metal industry

(*Continued from page 9*)

complete. The escape of the carbon-oxygen gases left a spongy mass, which could then be pressed, heated, or forged to a desired shape. Today the reduction process is far more versatile. It is accomplished by first pulverizing the metal oxide into fine powder and then reducing the more easily attacked mass by passing hydrogen gas over the mix or by addition of suitable reducing agents. The temperatures required are dependent, to a great degree, on the size and type of the metal. It has been found that low temperatures are feasible when the particles are fine. As a matter of fact, high reduction temperatures are not practical as they would tend to sinter the powder and therefore form solid crusts. The reader may be unfamiliar with the sintering operation — the fundamental process of powder metallurgy. Probably the most widely accepted theory of sintering is that it is the mechanism by which solid bodies are bonded together by atomic forces through the application of pressure and/or heat. Theoretically, however, neither pressure nor heat is necessary for an atomic bond, since there is a natural attraction between atoms. This atomic force is given by the equation: Force $= \frac{-mA}{r^{m+1}} + \frac{nB}{r^{n+1}}$, where m, n, A, and B are constants and r the distance. Heat causes an interchange of atoms which results in a plastic deformation, thereby increasing the surface area between particles and, as a result, their cohesive bonding force. The increase in area is brought about through a plastic deformation or spreading of the particles. Pressure also serves to increase the atomic bonding by the creation of friction heat and induced deformation.

A second method of producing metal powders is that of atomizing or spraying metals of low melting points. This method is widely used for such metals as lead, tin, zinc, and cadmium — all melting below 700° C. However, this method has had limited success when applied to copper, silver, nickel and iron powders. Essentially, atomizing consists of forcing molten metal through a small orifice and having it drop, under the gravity force, onto a stream of compressed air, steam or inert gas. Upon collision the stream is shattered and finely powdered — the powder being carried over classifying and sizing screens and then mixed and packed.

A method of a more chemical nature is the "precipitation process." This took root in the first quarter of the nineteenth century and was probably the first scientific approach to the metal powder field. The experiments, published by Wollaston in 1829, dealt with the production of a platinum object of high purity and good properties. Wollaston first precipitated ammonium-platinum chloride from solution, then induced the change of the precipitate into a loose, spongy powder by igniting and low heat. Grinding of this sponge was followed by the removal of both foreign and volatile matter by sieving and washing, respectively. After separation of the coarse from the fine powders by sedimentation, the fines were moist-pressed under high pressure. This pressing was followed by careful drying of the wet cake in a reducing fire with the subsequent removal of moisture and adsorbed gases. Further heating at a higher temperature, with its marked sintering effect, resulted in a strong bond of the powder particles and a coherent platinum piece.

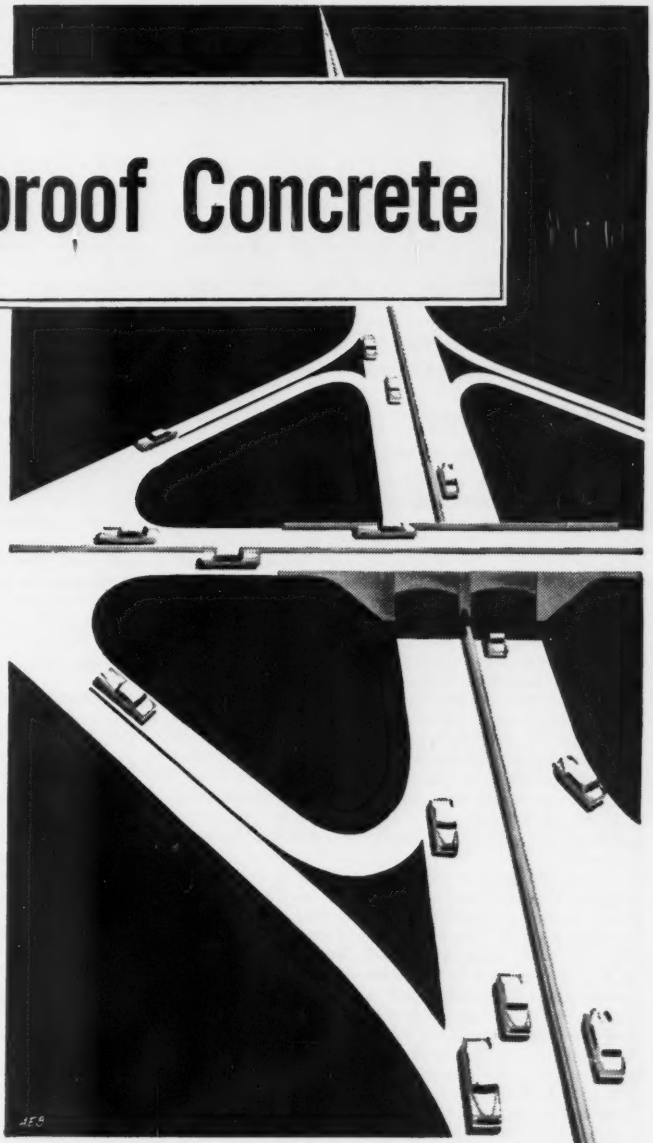
A glance at your 5.02 notes will bring to mind other chemical principles which are used in the production of powdered metal. The familiar electromotive series predicts the precipitation of a metal from solution with the addition of a metal which is higher in the series. In this manner tin is produced in quantity from a stannous chloride solution upon the addition of metallic zinc. Similarly silver nitrate is transformed to copper nitrate with the introduction of metallic copper. The reader can easily deduce other possible applications from the electromotive series.

Another powder production technique to be mentioned is the interesting intergranular corrosion method developed at MIT. The method, successfully applied to stainless steel, consists of subjecting the mass of metal to a carburizing heat treatment between 500° and 700° C. and the formation of carbide precipitates in the grain boundaries of the metal. The further treatment of the metal by a mixture of $CuSO_4$, H_2SO_4, and water used as a corrosive agent results in the dissolving of the intergranular precipitate and leaves a completely disintegrated metal.

The technical demands made of the pressing mechanisms are high. The pressures needed for the compacting of the powder vary over a very wide range, depending on the type of powder being pressed, the subsequent sintering operation, and the use to which the finished object is put. Pressures between two and five thousand tons per square inch are used industrially, with much higher pressures available for special purposes and experimentation. However, the attainment of very high pressures is not the most significant problem in the pressing operation. It should be recognized that metal powders do not follow the laws of hydrodynamics and therefore pressure is not transmitted equally throughout the compact. In fact, the pressure decreases propor-

(*Continued on page 28*)

Climate-proof Concrete



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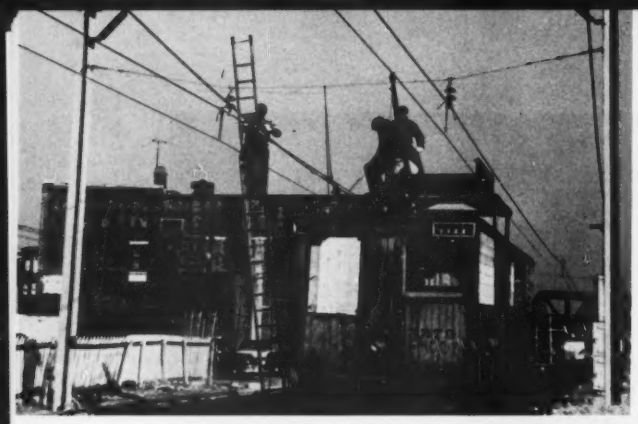


Old trolley line-car assists linemen installing catenary overhead system near Orient Heights.

transit for the future

(*Continued from page 11*)

These wires are carried on a supporting system consisting of simple cross spans of stranded steel cables, carried by wide flange structural steel shapes on each side of the tracks. These shapes, the most economical supports for this type of system, vary in size between ten by ten inches, forty-nine pounds per foot, used on all tangent track construction, to twelve by twelve inches, one hundred and six pounds per foot, used at curves and dead ends and at the Orient Heights Yard.

Aside from supporting the contact wire, the messenger wire provides additional conductivity. Most important for current carrying capacity is the Neoprene-covered distribution cable of 1,000,000 cir. mil that is carried on the overhead supporting poles on either side of the tracks; it is connected to the messenger and contact wire at 800-foot intervals.

Power is returned through one of the two running rails of each track and a supplementary Neoprene-covered return cable of 2,000,000 cir. mil buried between the tracks.

A new mercury arc substation is being built at Orient Heights; this will supplement the present East Boston rotary converter substation in providing 600-volt D.C. on the extension. The new unit will receive 13,200-volt, 25-cycle A.C. from the South Boston and Lincoln M.T.A. power houses by means of three lead covered cables running underground from the existing East Boston Substation at Eagle Square. One one-thousand and one fifteen hundred kilowatt pumped type tank mercury arc rectifier and their associated step down transformers will convert the three-phase power to 600-volt D.C. power for train operation. Frequency conversion equipment will supply 575-, 208-, and 120-volt 60-cycle A.C. power for shops, stations, signals and lights. The substation will be completely automatic, controlled only from the South Boston power supervisory board.

All cars operating on the extension will naturally have to be equipped with collectors to receive current from the overhead system; these collectors are pantographs, similar to those used on the New Haven and other main line railroads. In the old tunnel itself the third rail will continue to be used because of the restricted clearances; from Maverick inbound the clearances are so tight that the old trolley wire had to be removed to prevent shorts by its contact with the pantographs in locked down position. An insulated section of overhead wire will be erected on the inbound side of Maverick Station; this will be used as a signal circuit to prevent operation of trains east of Maverick with pantographs raised. Interlock switches will disconnect the motors and controls from the third rail and connect them to the pantograph when it is raised.

All old East Boston Rapid Transit cars are having pantographs installed, one to every pair of cars, and a number of other changes are being made to permit their operation over the new extension. Included in these changes is the installation of headlights, to be used when the cars are operating out of the tunnel, and new windows for the operator's cabs. Both headlights and cab windows have polaroid screens, oriented so as to eliminate glare from headlights.

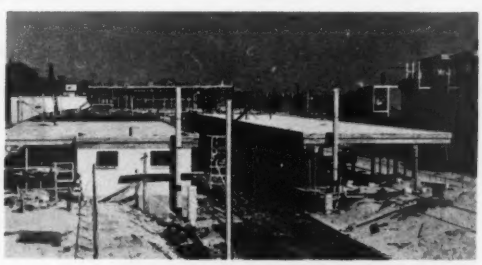
The forty new cars delivered for this line from the St. Louis Car Co. employ both the pantograph current collectors and the polaroid screens; and in many ways the most modern rapid transit cars yet constructed. The designing of these cars was carried out in cooperation with the Rapid Transit Equipment Subcommittee of the American Transit Association. This group included representatives from Cleveland, Toronto, and Chicago, as well as Boston; all wanted a lightweight, modern rapid transit car for purchase now or in the near future. Although size of loads, clearances, and operating conditions prevented complete standardization, the committee agreed on many features of the new cars. Such items as the Cineston controller, a single unit for accelerating, running, and braking, and the car trucks (assembly containing wheels, motors, etc.), a derivative of the trucks used on P.C.C. streamlined trolleys for smooth riding and silent operation, are now standard equipment on modern rapid transit cars.

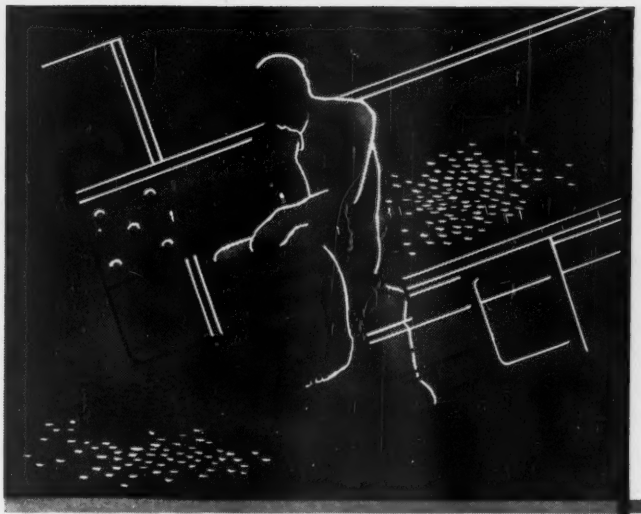
Other similarities may be noted between these new cars and the latest fifty P.C.C. streetcars now used in Beacon Street-Subway service. These include the thermostatically controlled overhead fans for ventilation and cooling, the heating coils utilizing normal acceleration and dynamic (motor) braking current losses, and the cars' most distinguishing feature, their large picture windows, measuring over four feet in width and three feet in height.

Inside the car, the passenger will enjoy sitting on the maroon composition leather seats running the length of the car. Those who stand will hold stainless steel grab handles and stanchions, under two rows of lighting fixtures again similar to those in the M.T.A. modern streetcars. Every effort has been made to eliminate horizontal surfaces or projections which might collect dirt, even those under windows.

(*Continued on page 28*)

Orient Heights Station is nearing completion.





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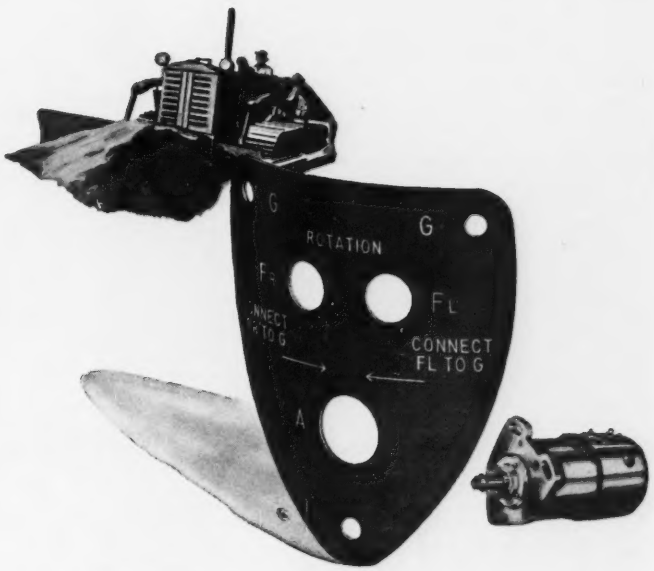

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When it comes to moving mountains—or spreading the landscape around—you can't beat bulldozers.

You can, however, beat a bulldozer if you put into it a part that can't stand the gaff.

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PLASTICS WHERE PLASTICS BELONG

SYNTHANE

metal industry

(*Continued from page 22*)

tionately with distance from the pressing punch. This is a serious shortcoming as the final product will not be uniformly dense and will be of questionable value as regards mechanical strength. This problem of distributing pressure throughout the mass also is the limiting factor in designing parts suitable to powder production. Perpendicularity with respect to the plane of the pressing punch is the keynote. The multiple punch press serves to apply pressure at opposite sides of the compact, and therefore distributes the pressure more evenly. The presses generally have large production rates. Depending on the size of the object, the rate can go as high as fifteen hundred compacts per minute. However, a figure of three hundred pieces per minute is more common. In order to acquaint the reader with some of the progress in the field, a few recent advances will be mentioned. One innovation deals with the application of powder to weapons. The all-important rotating bands on the back of projectiles have been made primarily of copper. With the advent of higher velocity artillery there was a tendency for the rotating band to fuse with the spiral carrier. Another limitation is the extreme scarcity of the copper metal. The use of iron powder, the only powder which has maintained a low and fairly stable price, has been advanced as an alternative. The powder has properties of ductility, corrosion resistance, high melting temperature, and economy. The present output of six to eight hundred thousand pounds of powder per month for this purpose is expected to increase by six hundred per cent in the near future.

As has been mentioned previously, the lack of hydrodynamic transmission of force through a powder cake has, to a great degree, restricted the size and particularly the length of objects susceptible to the powder process. Recently the pressure welding technique has been advocated. This method consists of the joining of smaller parts by such low pressures as 2.2 psi, and a temperature of about one thousand degrees. The flux is wetted, finely divided iron powder which becomes strongly sintered to both pieces to be joined, and seals a weld not detectable on machining. The present technique of extruding a paste of hard metal powders has been a practical method for the production of long lengths of rods, tubes, angles, and even twist drill forms.

Engineering development is highly dependent upon the attempt to originate metals that meet its needs. Problems concerned with turbo-superchargers, gas turbines, jet engines for aircraft, and power plants utilizing nuclear energy demand materials of high strength and corrosion resistance at elevated temperatures. The correlation between mechanical strength and melting point has been established. Therefore, metals and metallic compounds of high melting properties are the ones to which great attention is being paid. These metals, such as tungsten, molybdenum, the carbides and borides of refractory metals are now being investigated with encouraging results. The difficulty in fusing such materials points to the powder method as the most feasible approach.

As to the general future of the powder field, indications are favorable. Powder metallurgy is certainly no panacea. It has its limitations both in technical and economic aspects. However, the science is still new and many developments can be expected.

transit for the future

(*Continued from page 24*)

When the extension begins operation the entire transit picture in East Boston, Chelsea, Orient Heights, and Revere Beach will be changed. No longer will the surface lines bring the rider all the way to Maverick Station. Instead they will head for the station closest to the area they serve. Only three out of the present seven M.T.A. surface lines and none of the private bus companies will continue to operate to Maverick Station. The M.T.A. intends to abandon the present streetcar incline and loading tracks rather than spend the money necessary to convert the transfer station to trackless trolley operation. The three remaining bus lines will load on the surface.

From the beautifully designed Airport Station bus platform the Airport bus will have a three-minute trip over an express road direct to the Administration Building, instead of the present time-consuming journey from Maverick over East Boston streets. The Airport bus and the East Boston Tunnel will together provide Logan Airport with better transit service than any other airport existing.

Day Square is to be the primary transfer station for M.T.A. trackless trolley lines. From the upper level of this station these vehicles will run to Woodlawn, Orient Heights Station via Bennington Street, and to Revere Beach via Chelsea. Orient Heights is to be the transfer point for private bus lines feeding the rapid transit line. The Eastern Massachusetts bus line from Lynn will no longer run downtown or to Maverick Station, but will terminate at Orient Heights. In addition two M.T.A. trackless trolley lines will enter the station, one south to Day Square, the other north to Revere Beach. Both these routes will cover territory now served by the Maverick-Revere Beach via Orient Heights car line. Approval must be given the M.T.A. for replacing trolley lines operating on the street by trackless trolleys, after the heavy loads handled by these streetcar lines are turned over to the Rapid Transit. This is exactly what the M.T.A. will do with the lines north of Day Square. However, the route from Orient Heights to Revere Beach is a special case. Heavy loads will continue to be handled by this line, not only during rush hours, but on summer weekends as well. Only minor trackage construction would have been needed to bring this car line into Orient Heights Station, with a track connection to the new overhead, wire-equipped Orient Heights Yard for car repair. The M.T.A. might be criticized for not using this opportunity to give Revere Beach a rapid transit service now; it is difficult to see why a transit authority would spend money to remove its passengers from street congestion to carry them on its own right of way, then turn about and spend more money to return them to the street.

Revere may have rapid transit anyway. The M.T.A. already owns the old "Narrow Gauge" right of way paralleling its streetcar right of way to Revere. The 1945 Recess Commission approved not only the extension to Orient Heights, but also a further extension over the old Narrow Gauge roadbed to Revere and Lynn. The most important obstacle is, of course, the appropriation of money. But, as traffic conditions become worse and the need for rapid transit greater, legislators are becoming increasingly concerned about the North Shore commuting problem. It may not be too long, then, before the first East Boston Tunnel train leaves Bowdoin and Scollay Stations, its front sign reading "Lynn via Revere."

...Yet this Hindu Fakir is taking steps to demonstrate a basic refractory principle. For it is the ability of refractory materials to withstand the effects of high heats that makes them industrially important as linings in kilns, furnaces and other heating applications. Other properties of refractories have since made possible improved and advanced processes in low as well as high temperature ranges. Where abrasive and corrosive action in addition to the heat factor have caused ordinary refractories to fail, it has been necessary to develop Super Refractories such as those made in our New Jersey plant.

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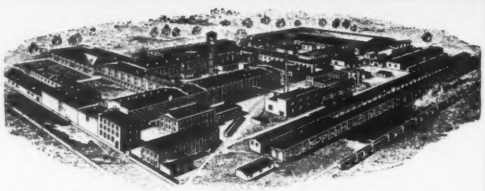
ostheimer's rule

(*Continued from page 13*)

He had asked for volunteers, two volunteers for the flight. He received one reply, that of Maffey Nikkersson, old Nikkersson's boy. There were no more offers forthcoming. He and young Nikkersson knew what they were up against this trip; they had discussed Ostheimer's new theories carefully. Young Nikkersson, who was a physics graduate at an Eastern college, helped Ostheimer immeasurably in trying an analytic check on his deductions through old Nikkersson's basic equations of the drive. It was strange that old Nikkersson had never chanced to uncover this corollary of the drive equations, but that is quite often the case . . . the discoverer is sometimes too close to his own work. Ostheimer chuckled at young Nikkersson's reaction when they saw that the corollary was a valid deduction. That was probably why he readily and confidently volunteered. Ostheimer felt, though, that Maffey would have come along in any event.

In the following hours it was all over. A successful set of runs to the Moon, Venus, Mars, Jupiter and Saturn, each trip an actual contact or verifying brushing contact with the planet under consideration. The stalemate was over. The astronomers were right, and Ostheimer was overjoyed that they were right. The Earth was not relatively contra-terrene with respect to the solar system's members, but even in retrospect, Ostheimer saw that his first conclusions followed from the information he had at the time. It was the corollary that he and young Nikkersson deduced that transformed a phantom isolation into one of unshackled freedom of the entire universe, barring nothing. Even contra-terrene planets were now, ironically, within the sphere of admissibility to the Earth system. For, the corollary of the basic Nikkersson equations stated that during a single power run of the Nikkersson drive, the molecular structure of the ships material, including everything within the ship, was reversed; electrons had positive charges, protons had new, negative charges. If the power run was split into two parts, the reverse would occur twice, and the ship would be "normal" again. If the power run was split into three distinct parts, the ship would be relatively contra-terrene with respect to the earth, and so on. It all tied in very clearly; the tragic deaths of his men, and loss of the first Nikkersson drives were now easily explained. Even the original Nikkersson experiment with the copper cube was clear now in the light of the corollary. Young Nikkersson verified Ostheimer's suspicion that the original experimental set-up had luckily incorporated in it a double-pulse transmit signal.

Ostheimer rose and carefully stretched his old legs. He clapped the ashes out of the pipe and pocketed it. He leaned with both hands on the white railing and drank in deeply the mingled fragrance of the Havernut blossoms and the tingling sea air. He straightened and turned toward the cottage door. It opened quietly and swiftly as he approached it, and closed quietly behind him. He felt need of an afternoon nap.



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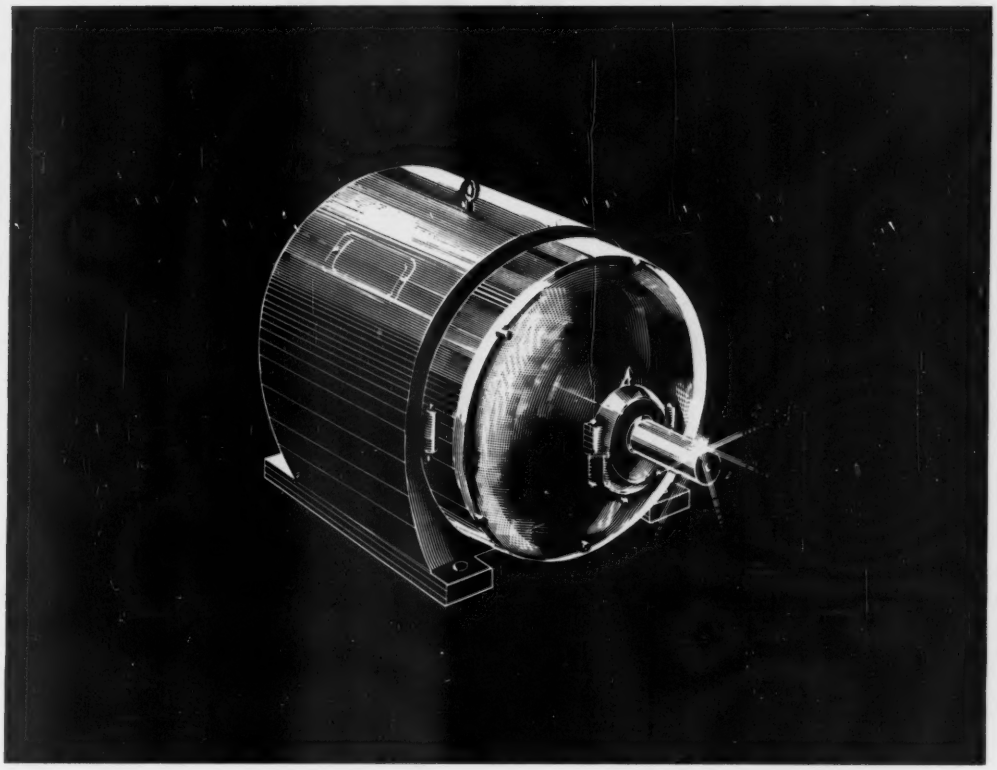

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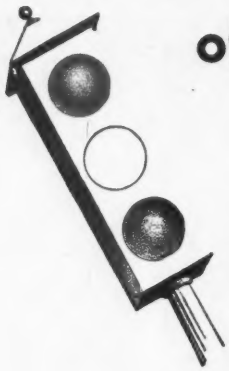

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KEL-F's resistance to chemical action, low cold flow, wide range of temperature application and exceptional flex life combine to make it the most important diaphragm development in years. KEL-F is chemically inert to all organic acids and alkalies in all concentrations. It withstands chlorinated aliphatic and aromatic compounds, concentrated nitric, chromic, hydrofluoric and sulphuric acids and most solvents which readily attack rubber and previous synthetic diaphragm materials.

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briefing the news

Heat "Drills" Holes in Rock . . .

A jet-piercing machine, thermodynamically similar to the giant rockets being tested for military use, has proved to be the key that will unlock thirty to forty million tons a year of hitherto unmineable iron ore from Minnesota's vast iron ranges, and the first announcement of its commercial acceptability has been made. The jet-piercing process, a revolutionary development capable of "drilling" as much taconite rock in one day as the old churn-drill methods can accomplish in a week, has been tested under a variety of conditions since 1949 at the Erie Mining Company operations at Aurora, Minnesota, and the results have been startling.

The problem of drilling through taconite, an iron-bearing rock of extreme hardness, has baffled mining engineers since 1916, when the famed Daniel C. Jackling formed the Mesabi Iron Company in an effort to mine the magnetic rock. But it took the utilization of the principle of thermal energy to conquer the taconite drilling problem.

The new jet-piercing machines, developed by the Linde Air Products Division of Union Carbide and Carbon, direct 4300° F. supersonic jets of flame at the tough rock at a speed of 6000 feet per second. Stresses induced in the rock by the high temperature cause thin layers to break away, thus exposing the underlying rock. So effective is the jet action that "drilling" speeds of 60 feet per hour have been attained under ideal conditions. Liquid petroleum fuels (kerosene, Diesel oil, or No. 2 fuel oil) are burned with gaseous oxygen in a combustion chamber at pressures of 100 to 200 pounds per square inch to produce the flame which "burns" the taconite. The flame is forced out through nozzles in a slowly rotating blowpipe that is lowered into the drill hole by a winch in the cab of the machine. Although the jet-piercing process costs as much per ton as the conventional churn drill methods, the industry is enthusiastic about the fact that one jet machine can do the work of eight churn drills.

Rubber Glued to Steel . . .

A method of joining silicone rubber to steel and other surfaces in a permanent bond stronger than the rubber itself, has been discovered by General Electric Company chemists. Key to the process is a thin, glue-like "primer," which forms a strong bond between silicone rubber and many surfaces besides steel, including glass, ceramics, aluminum, tin, and copper, according to the company's research chemists. Development of the primer increases the usefulness of silicone rubber in structural combination with metals.

Typical applications would include engine and shock mounts. Engines mounted on silicone rubber would produce greatly reduced vibration. Delicate aircraft instruments similarly mounted would be less subject to damage by severe wind buffeting of aircraft or shock in landing. Heavy-duty washers or gaskets made of tough glass fibre bonded between layers of silicone rubber may also find industrial application.

Adjustable Voltage Controls Crane . . .

Crane controls so sensitive they can regulate the movement of a 250-ton load to within one thirty-second of an inch were tested recently at McNary Dam by the U. S. Army Corps of Engineers.

Developed by Westinghouse Electric Corporation, the new adjustable-voltage control has been installed on the first of two massive 200-ton gantry cranes. These cranes will be used to raise and lower the 126-ton spillway gates at the Dam. When a gate is raised, the load on the crane approaches twice the weight of the gate, due to the downward pressure of the water rushing under it. The adjustable-voltage control embodies speed-torque characteristics that inherently cause the motor to slow down in both the hoisting and lowering cycle when the load is increased, without change in the setting of the control. The control monitors — or measures — the load on the motor, and adjusts the speed accordingly, using a Rototrol rotating regulator.

THE DU PONT DIGEST

M.E.'s AT DU PONT [2]

Challenging variety of problems solved by research and development engineers

As a student of mechanical engineering, do you look forward to a future in research, development, plant engineering or production supervision?

In the *Digest* this month, we'd like to discuss the ample outlet Du Pont offers your talents in these fields.

Let's talk about research and development together because they often overlap indistinguishably. Both these fields deal with mechanisms for making products. In some cases, original equipment is designed for a new product. In others, machinery used in making existing products is improved to provide better quality at lower cost.

This design and development work may call for studies of the vibration of machine elements, equipment, structural members and structures. Or there may be need for application of electronics, instrumentation, operation of test equipment and testing of experimental machines. In much of this activity there is close cooperation with other engineers, participation in group conferences, joint analysis of data, and issuance of recommendations.

J. D. McHugh, *B.S.M.E., Rochester '50 (center), consults with D. B. Berlien, B.S.M.E., Purdue '36 (right), and J. F. Crawley, Jr., M.S.Ch.E. '47, V.P.I., on installation of equipment in the field.*

Du Pont research and development engineers keep informed of developments through technical, trade and patent literature, seminars and lectures. Exceptional facilities for these are provided.

Here are some examples, specific and general, of the problems that confront Du Pont research and development engineers:

1. Develop and design high-speed slitting equipment for thin films. Involved are unwind and wind-up tension regulation, alignment of web travel and cutting-knife selection, combined in a machine easy to service.

2. Design equipment to operate at pressures up to 45,000 p.s.i. This is insurance against the time when processes may be developed that will operate in this range.

As pressures are increased, design problems for moderate pressures are magnified. Typical are stress-fatigue of metals, design of vessel closures and line joints, valves and packing for reciprocating compressors and centrifugal pumps, packing glands for stirred autoclaves, etc.

3. Design, installation and testing of large air-conditioning systems necessary in the manufacture of certain products. In one plant, water is used at the rate of 50 million gallons daily, current at 25,000 kw. per hour, and air at 5.5 million C.F.M.

These three examples, selected from literally hundreds, can only hint at the breadth and variety of the problems that are constantly arising.

Albert Rand, *B.S.M.E., M.I.T. '50 (right), and Rane Curl, M.I.T. '51 (summer worker), develop controls for chemical equipment.*

R. T. Bradshaw, *B.S.M.E. '46, M.S. '47, Queens U., Ireland, and J.D. McHugh, B.S. M.E., check theoretical calculations.*

One of the strongest pieces of evidence that mechanical engineering is of major significance in the Du Pont Company is the existence of the Wilmington Shops. They represent an investment of over $3,500,000 and cover an area of 300,000 sq. ft., including a foundry and pattern shop. They employ over 800 men and have a potential output in volume of work in excess of $6,000,000 a year.

The size and diversity of this operation are justified only because the work of mechanical engineers is an important factor in Du Pont operations.

NEXT MONTH—*Opportunities in plant engineering and product supervision will be discussed in the third article in this series, "M.E.'s at Du Pont." Watch for it!*

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There's real opportunity for engineers at Honeywell—for this is the age of Automatic Control—everywhere you turn.

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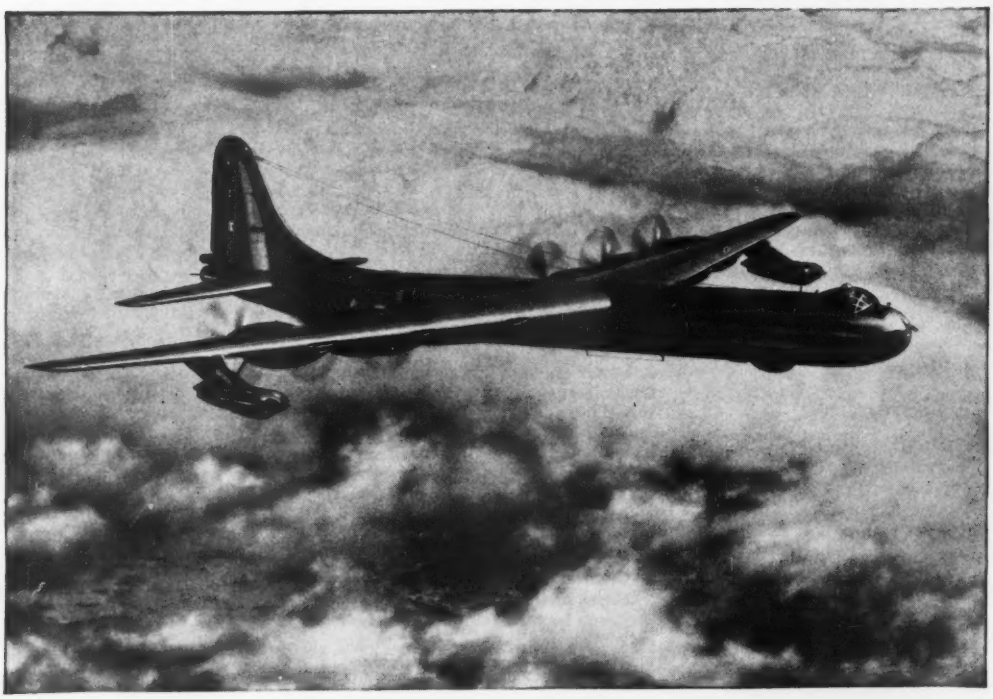

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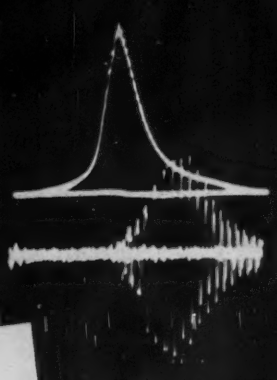

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Engineering makes good use of photography's flashing speed

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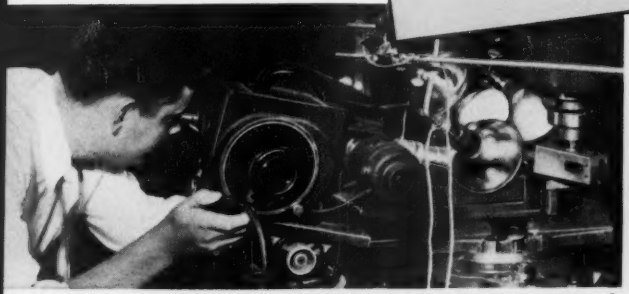

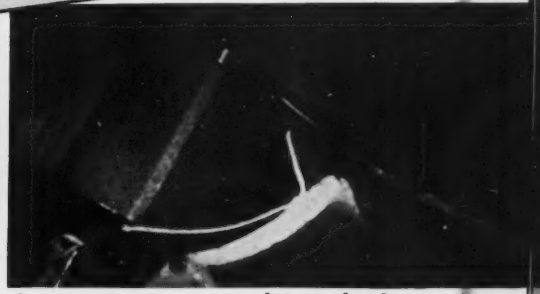

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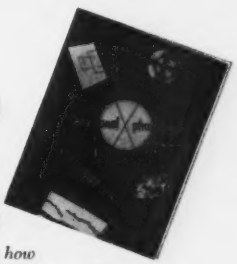

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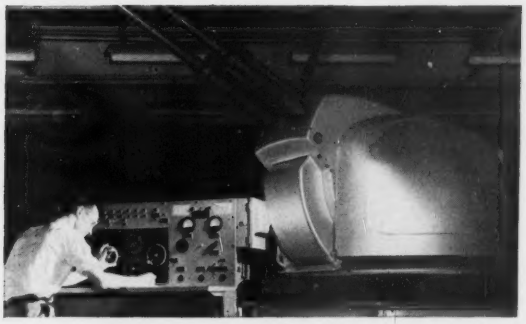
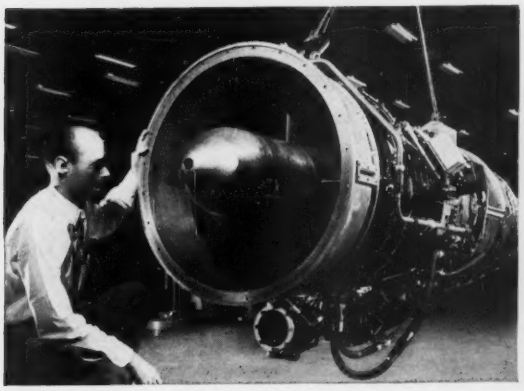


A gun turret for the B-36 bomber undergoes test as it comes off the assembly line at a General Electric plant.

G-E engineers developed this portable steering unit which enables Navy ships to be steered from any of several widely separated strategic positions.



An advanced model of General Electric's J-47 turbojet engine packs far more power within the same size.

Ideas from college graduates at General Electric are helping U. S. mobilization

Add to the above the nuclear-powered aircraft engine that General Electric is developing for the Air Force . . . turbosuperchargers . . . guided missiles . . . radar . . . the plutonium-producing reactors which the Company operates at Hanford, Washington for the Atomic Energy Commission.

Into vital national projects like these are going the efforts of hundreds of scientists, engineers, chemists, physicists and other college graduates who are making their careers at General Electric.

There's a major reason why General Electric is asked to contribute to so many of these projects. The Company has prided itself on building an outstanding engineering, technical and business organization, one that can take the toughest problems and master them, one that can be a steady source of new ideas.

Young people from American colleges and universities, their skills and talents further developed through G-E training courses and rotational job programs, are forming the core of that organization and are the source of the ideas that are standing the nation in good stead.

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